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PROVINCE OF BRITISH COLUMBIA.

DEPARTMENT OF AGRICULTURE
(HORTICULTURAL BRANCH).

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FRUIT-TREES AND BLACK-SPOT CANKER.

BULLETIN No. 34.

THE GOVERNMENT OF THE PROVINCE OF BRITISH COLUMBIA

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DEPARTMENT OF AGRICULTURE,
VICTORIA, B. C., September, 1911.

Hon. Price Ellison,
Minister of Agriculture.

SIR,—I have the honour to submit Bulletin dealing with the injurious effect upon fruit-trees by black-spot canker, and which has been compiled by J. F. Carpenter, B.S.A., Assistant Provincial Horticulturist.

I have the honour to be,
Sir,
Your obedient servant,
WM. E. SCOTT,
Deputy Minister of Agriculture.

BLACK-SPOT CANKER.

In view of the large amount of injury to fruit-trees due to the work of the black-spot canker (often termed anthracnose, black-spot canker, black-spot apple-tree canker, and even sour-sap disease), and in view of the large number of people coming into the Province, not conversant with this disease, who will have more or less to do with tree fruits, it is thought expedient to give to the public at this time, in the form of a concise practical bulletin, a short treatise on our present knowledge of the history of the disease, its habits and methods of prevention. By so doing it is hoped that systematic and general work will be started this fall in order to prevent in so far as possible with our present known methods, future damage by this pest of our orchards.

EXTENT OF DISEASE.

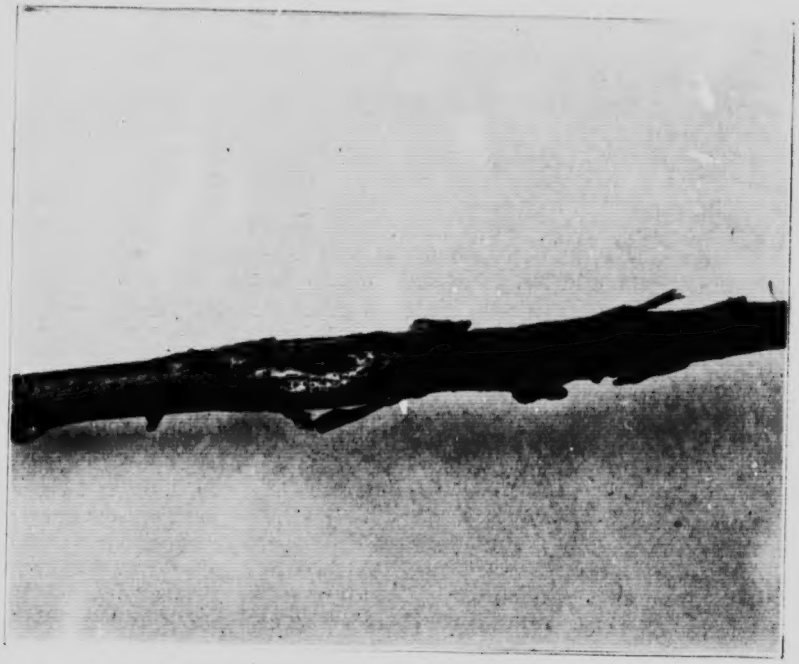
This disease is to be found in British Columbia, Oregon, Idaho, and Washington, but is not known in Eastern Canada or the Eastern and Middle States at the present time. It is especially serious in the Coast districts, where the rainfall is heavy and the humidity high in the latter part of the year. Fungous diseases flourish best under moist atmospheric conditions, so it is to be expected that this disease would be most prevalent in the Coast districts. Damage due to this disease in British Columbia was reported as early as 1901 by Mr. R. M. Palmer, but it is only a comparatively few years since the cause of the injury was known, and we were able to determine satisfactory and economical methods of prevention. In the United States it seems to have been noticed first about 1891 or 1892, for in 1894 it had attracted so much attention that Dr. Newton B. Pierce, of the United States Department of Agriculture, was detailed to make an investigation, and determine, if possible, the cause of the injury. He proved it to be due to a fungous disease. Recently Prof. W. H. Lawrence, of the Western Washington Experimental Station, issued to the public, in the form of a bulletin, [illegible] results in detail of two years' study of this disease, and he has brought [illegible] number of good points as to the nature of the disease and methods [illegible]on, showing also that it attacked the fruit. There are other bark-[illegible]s be found in British Columbia, such as black-rot canker (*Sphaeropsis* [illegible]*um*), which might be mistaken for this disease, but these are due [illegible] different fungus and require different treatment.

EXTENT OF INJURY.

It is difficult to realize the damage done by this disease. Most of the insect pests of our orchards come to us year after year, causing damage to the various parts of the tree, and the results of their ravages are seldom noticed the following year, unless in the form of a general weakening of the vitality of the tree, which it is difficult sometimes to associate with the attack of the insect. Black-spot canker (the name generally accepted by fruit-growers in British Columbia to designate the disease) not only causes injury by sapping the vitality of the tree by living parasitically on its life

food material, but also causes more or less permanent injury to its organs by destroying sections of them entirely, that takes years for the trees to replace, and which sometimes never heal over. With the destruction of certain parts of the organs of the tree, the work of the tree in producing high-class fruits is proportionately impaired. These injuries form an excellent medium for the attack of other fungous diseases and for the attack and protection of certain insect pests. Control of pests is made more difficult in a tree more or less injured by the disease, as thorough work in spraying is made much more intricate than on a healthy clean-bark tree. By observing orchards in British Columbia, especially in the Coast districts, we frequently notice trees with dead and dying limbs or a more or less sickly appearance making poor growth, which on close examination reveal the principal cause of their condition as black-spot canker, sometimes with subsequent attack of woolly aphis, some form of Nectria or other pests often associated with the disease. With these facts in view, the fruit-grower who is financially interested in his orchard, and who does not want to have an orchard which is a menace and an eyesore to his district, can realize the importance of becoming acquainted with the nature of the disease, as also proper means of prevention and remedies, making use of them to the best of his ability.

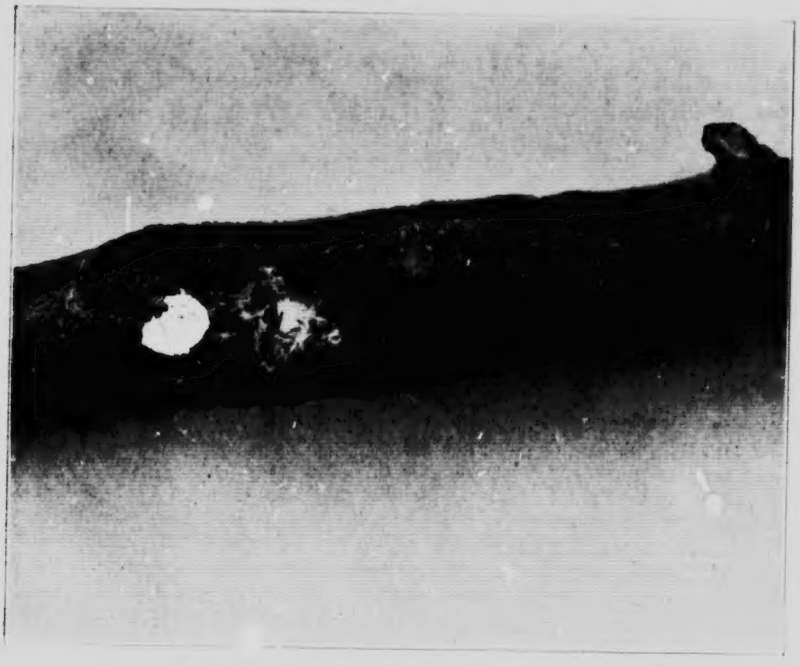
The disease attacks the apple-tree, causing injury to trunk, limbs, and fruit. Cankers similar in appearance have been found on the plum, prune, and cherry, but the writer is not aware that satisfactory proof has been found to positively connect the fungus with the canker, although they show a notable resemblance.



Limbs of apple-tree showing cankered area with subsequent attack of woolly aphis.

SUSCEPTIBILITY OF VARIETIES.

The comparative susceptibility of varieties is an important question to the prospective planter of an orchard. In an experimental orchard at Agassiz, where some eight or ten varieties were planted twelve or more years ago in variety rows of ten or twelve trees to the row, the only two varieties which remain practically intact are the King of Tompkins and Grimes Golden. Most of the trees of the other varieties have been seriously damaged or entirely killed by the black-spot canker. Grimes Golden has been damaged more than the King of Tompkins, but not seriously enough to convince the writer that this variety could not be kept clean by proper treatment. Although we were not aware of the results as obtained there until after the demonstration orchards in the Coast districts were planted this spring, it bears out our belief that, in the selection of the varieties for those orchards, we were obtaining varieties which were less susceptible to black-spot canker than others. Some varieties which have been noticed as most often attacked are Gravenstein, Wealthy, Baldwin, Wagner, Yellow Bellflower, Winter Banana, Duchess, Yellow Transparent, and Spitzenburg. Of the varieties noticed showing less damage from disease there are King of Tompkins, Grimes Golden, Rome Beauty, Hyslop Crab, (all Crabs), Northern Spy, and Ben Davis. This variety list is not given for the purpose of influencing the intending planter against setting out any of the above varieties, but more to convince him that they differ as to their susceptibility, and that in selecting varieties it might be well to give this point consideration, especially where their merits otherwise are nearly equal.



Black-spot canker on an apple-tree.

GENERAL APPEARANCE OF INJURY.

The casual observer who has had little experience with the disease will probably first notice its attack in the spring about the time growth starts or a little later. It will then appear as an oval-shaped spot of varying size on the bark, slightly sunken generally with a smooth surface. is seldom found in older trees where the bark has become corky. This spot most likely had been attacked some time during the last two or three months of the previous year, and had been gradually developing to its present stage. If the tree had been carefully examined during the winter, when the disease was in its first stage, it would appear only as a slight discolouration of the bark, generally quite rounded, and on cutting into the spot it would be soft and of a slimy nature. As the period since attack lengthens, the cankered area becomes more sunken, firmer, and darker in colour. Increase in size is seldom noticed after the middle of May. During the late spring and summer months the face of the canker will become quite rough and with uneven, raised pustule-like bodies. The edge of the wound will often break away from the surrounding wood, which will begin to callous around it. The following winter or year the canker often breaks away entirely from the limb, leaving the wood bare, with the healing process taking place from the edge of the wound. This leads us to believe, from field studies of the disease, that the canker is only of one season's duration and requires reinfection yearly to carry on the disease, and this factor, providing other conditions were the same, makes the disease more easily controlled than if it had been perennial in the host.

The fruit is also attacked, and the work of the pest has been noticed principally in apples in storage. Prof. Lawrence, of the Western Washington Experimental Station, reports that he has transferred the disease to the trunk and limbs by inoculation from the diseased fruit. Where fruit is being stored, care should be taken to have storage conditions right (cool and dry) to prevent the spread of the disease. In the orchard the work of the fruit-grower should be directed towards controlling the disease on the tree, as if controlled there it destroys the only possible means of fruit infection in the orchard.

CAUSE OF INJURY.

Numerous theories have been advanced as to the cause of the disease. Frost injury, winter injury, and sour-sap have been frequently given in the past, but it has been definitely proved it is due to a parasitic fungus. It will not be necessary to discuss here the technical methods used to associate the disease with the fungus, as the majority of fruit-growers are satisfied provided they have a working knowledge of the disease. Suffice it to know that it is caused by a parasitic fungus termed *Macrophoma curvispora* by C. H. Peck, and *Glaosporium malicorticis* by A. B. Cordley, and black-spot canker, apple-tree anthracnose, etc., by the fruit-grower.

What is a fungus? This is possibly the first question that will arise in the mind of the fruit-grower when he is approached by the Orchard Inspector, who informs him that his trees should be sprayed for apple-scab, black-spot canker, shot-hole fungus, some other fungous disease. It might be termed a degenerate plant, in that it is a plant living as a parasite or as a saprophyte, or in conjunction with some other plant, and belongs to the plant kingdom. It is a microscopic plant. Most of us have seen the mould that starts on damp bread. This is a fungus. The white thread-like growth

is the mycelium or "roots" of the fungus, similar to the white threads in the soil of a mushroom-bed. Black specks which appear later contain the spores or "seeds." The plant does not require leaves or chlorophyll (green colouring-matter), as it lives on plant-food already prepared by the host

Trees badly attacked by black-spot cankers. Note dead twigs.

plant. Black-spot canker is one of these fungi which is parasitic in its habits, and by close examination with a microscope it is possible to find the mycelium or roots ramifying through the diseased portion, and the spores or seeds in their season near or on the surface of the cankered area, as described below.

INFECTION OF HOST AND GROWTH OF CANKER.

The canker as seen in the summer before the surface begins to get rough has practically completed growth, and during the remainder of the season it develops the spores. The pustules which rise on the surface usually indicate spore formation, and as the season advances they rupture the epidermis, allowing the spores to escape when weather conditions are favourable. The spores are contained in a gelatinous mass which is dissolved in water.

It is thought that the spores seldom spread and cause infection during the summer months unless under favourable weather conditions—*i.e.*, very wet. We believe that infection does not become serious until early in October or about the time the fall rains bring conditions favourable to the spread of the disease and its development. By making a careful examination of the young wood a month or so after that, we have found the disease started in the form of small, round, dark-coloured spots. During November and December most of the infection seems to take place, as it is after these months that nearly all the spots that develop into canker are noticed.

Injuries on the bark make a favourable place for the spore to lodge, germinate, and gain entrance to the underlying cell-structures. From observations taken it seems possible for the spore to gain entrance through uninjured and healthy bark, as cankers have been found starting where there has been no apparent previous injury. After germinating and gaining entrance, it works on the outer layers of wood for a short time and then gradually works its way through to the cambium layer, when it develops very rapidly. On cutting into a young canker you will sometimes find that it has developed in a much larger area than is indicated on the bark, and as it continues to grow this condition changes, making the mature canker, showing the same area of attack on the surface as in the underlying layers.

In the young trees up to three or four years of age all parts seem to be attacked without favour. As the tree grows older and the bark becomes harder, we find the principal parts of attack are in the young wood. It has also been noticed that the disease often starts around crotches, especially where the crotch is such that it will hold foreign material. On that account these bad crotches (crotches leaving the main trunk at a sharp angle) should be avoided as far as possible when starting the young head. Anywhere from one to hundreds of these cankers have been found in trees varying from ½ to 6 inches in length and ¼ to 4 inches in width. Where the cankered area is larger, this is often due to two cankers growing together.

CONTROL.

The same general principles of control of fungus pests in the orchard are applicable here. The spores of the disease require moisture to germinate, so it is advisable to select a site for the orchard (this has reference principally to the Coast districts) and handle the trees so to guard, as far as possible, against moisture remaining on the tree longer than necessary. Low lands should be avoided, not only on account of more danger from frosts, but there is little circulation of air there, especially at night, and as a consequence moisture will remain on the tree longer than where the orchard is on a side-hill or on higher ground. Good circulation of air in the orchard will keep the tree drier and in a condition less favourable to the attack of the fungus. On a side-hill, even on a still night, air will circulate down the slopes, as it always seeks the lowest levels.

Prune so as to permit good air-circulation and plenty of light. This is not only valuable in making conditions unfavourable for the development of the disease, but is necessary for the production of clean, well-coloured, and uniform fruits.

Keep the trees in a healthy condition by proper cultural methods. It is noticeable that we find the disease worst in poorly cared-for and neglected orchards. This does not prove that it will attack a poorly cared-for tree more readily than it will a healthy one, but that conditions for attack are more favourable. Injuries from insects and fungous diseases are found in greater

quantity there, and these form an excellent medium in which the spore can lodge and develop. Avoid injuries to the bark, such as "whiffletreeitis." Keep the tree in condition to withstand winter injury. A thrifty tree is in better condition to withstand attack and to renew any injured parts.

It would be advisable to gather the fallen fruit, especially in an orchard where the disease has been serious. This might form a medium for reinfection not only for this disease, but for others such as apple-scab. Hogs are satisfactory in the orchard for this purpose if ringed to prevent them from doing damage to the trees.

TREATMENT OF CANKER.

In addition to the above methods of control and spraying, it is a good plan to watch the trees closely, and where any cankers are found developing to open them with a knife. Cut open the canker, not necessarily into healthy wood, but enough to allow the air to gain entrance and dry out the spot. Leave this open for a day or so, and then disinfect the wound with corrosive sublimate, 1 to 1,000 (one of the cheapest and best disinfectants to use for tree injuries), or Bordeaux mixture (4-4-40). Paint over the wound with oil and lead, with some colouring material if desired (use no turpentine with paint).

SPRAYING.

Spraying to control the disease, when applied thoroughly at the right time with the correct sprays, has given satisfactory results, and has led us to believe that infection can be prevented by this method.

Knowing the habits of the pest as outlined above, the fruit-grower is in a position to appreciate the necessity of carrying on his spraying in an intelligent manner. The "roots" of the disease being situated under the outer covering of bark, it stands to reason that it would be impossible to destroy them without using a spray so strong that it would do serious damage to the tree. It is similar to the case of apple-crab (*Venturia inequalis*), where if you coat the scab with Bordeaux mixture or similar fungicide it will continue growth. It is impossible to check the disease with our ordinary sprays after it has started growth, and the control by means of spraying lies in a method of prevention. The spores are easily killed by a fungicide such as Bordeaux mixture or lime-sulphur, and prevention lies in spraying to kill the spores before they have germinated and gained an entrance into the host. These spores are microscopically small, so the reader can understand the necessity of thorough work in order to obtain satisfactory results.

TIME OF APPLICATION.

Where winter varieties of apples are grown it is impossible to use the ordinary sprays until the fruit is picked, and this is generally too late to obtain the best results. This is not important in the Upper Country, but it is in the Coast districts, where the disease does so much damage. Winter varieties of apples in the Coast districts are not to be recommended on this account. Spraying to control must be done early in the fall, about the time the fall rains begin. The leaves will likely be on the tree at that time, so, besides the control of black-spot canker, the spray will be beneficial in the control of other pests on the tree. Besides this spraying, the writer is of the opinion that another spraying should be applied immediately after the leaves fall, in order to insure thorough work, and to take the place of some

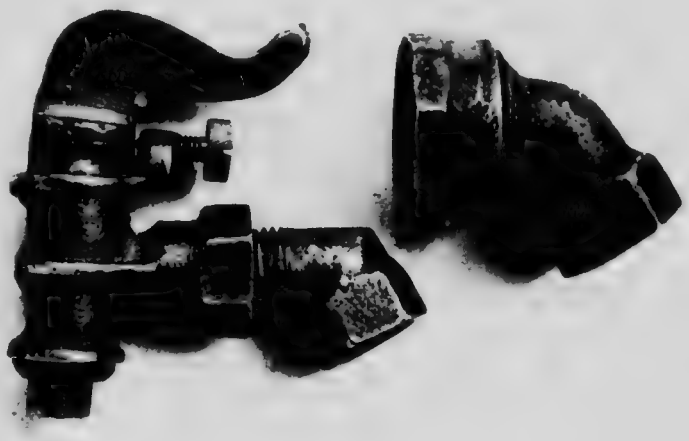
of the previous spray which might have been washed off by the rain. With these two sprayings thoroughly applied with a good spray mixture good results will be obtained.

SPRAYS.

There are numerous fungicidal sprays which could be used for the control of black-spot canker. Two of the best known and most generally used are lime-sulphur and Bordeaux mixture. It is difficult to say which is the best, but it is generally conceded that Bordeaux mixture sticks better and is a stronger fungicide than lime-sulphur, and will give better results in the fall spraying for the control of this disease. Lime-sulphur can be obtained at most hardware stores, and for this spraying a lime sulphur testing 32° Beaumé should be diluted 1 to 9 (1 gallon of lime sulphur to 9 gallons of water). Use Bordeaux mixture at its double strength (8 lb. good stone-lime, 8 lb. copper-sulphate, and 40 gallons of water), the manufacture of which is described below.

BORDEAUX MIXTURE.

Where the Bordeaux mixture is to be used in quantity it is advisable to make stock solution. To make a stock solution of copper-sulphate, put 20 gallons of water in a 40-gallon barrel; place in a sack (preferably of a coarse nature, such as a light bran-sack) 80 lb. of copper-sulphate (blue-stone); suspend this in the barrel so that the bottom of the sack is 5 or 6 inches under water. In a few hours, or at least a few days, the copper-sulphate will go into solution. Mark on the inside of the barrel the surface of the solution.



Nozzles of Bordeaux (flat spray) and circular spray fine with angle.

so that if any evaporation takes place it can be replaced with water. After the copper-sulphate is all dissolved, each gallon of the solution will contain 4 lb. of copper-sulphate. This proportion is given as an example, and can be varied to suit the requirements of the maker. It is not desirable to dissolve more than is required for a month's use, as it will become weak through recrystallization at the bottom of the barrel and require dissolving again.

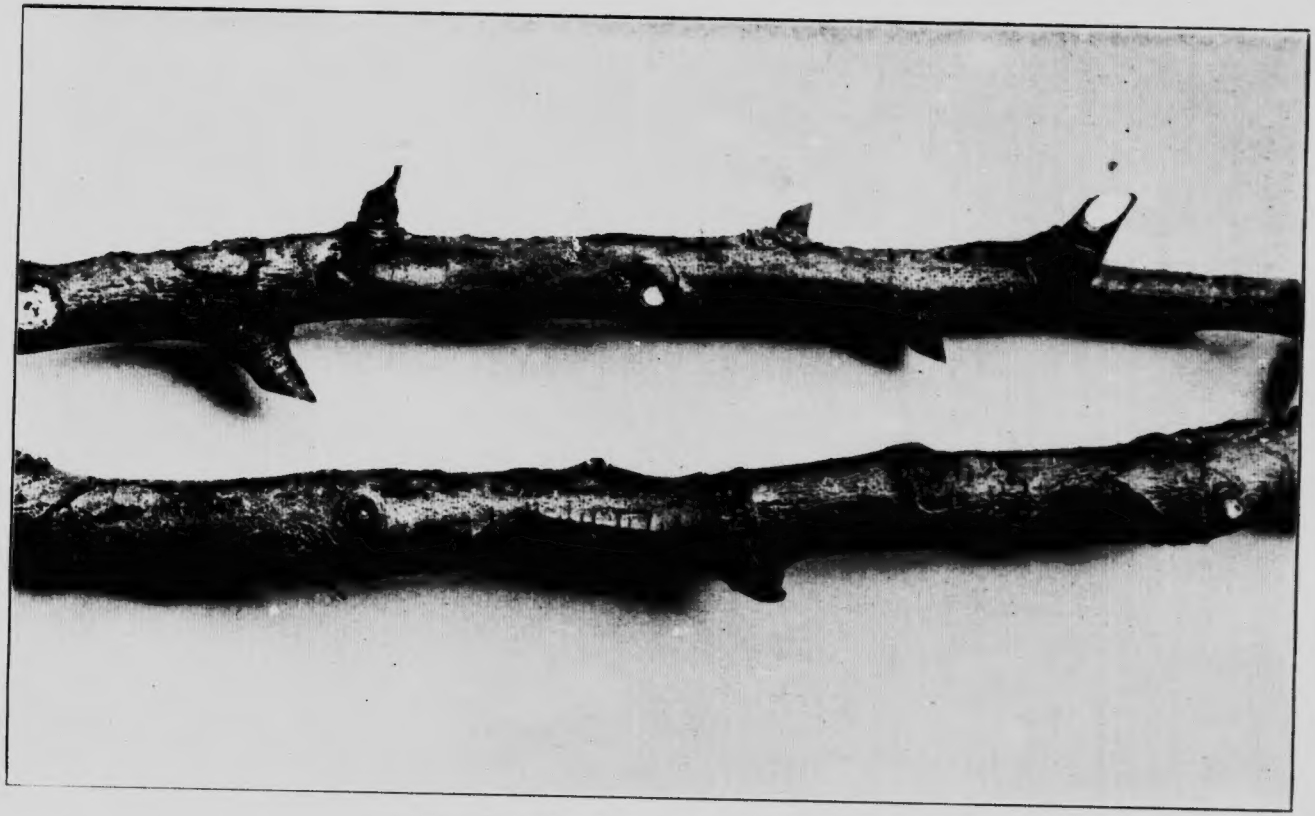
Lime.—Only good, fresh stone-lime should be used. This can be made into a stock solution also. In slaking the lime, use just enough water to make it slake rapidly without being allowed to powder, which indicates burning through lack of water. It is advisable to watch it carefully while slaking. If the lime is not of first quality, better results will be obtained through the use of hot water. In this way a smooth paste should be made which, when water is added, will strain readily. Dilute the milk of lime with water so it will be possible to know how many pounds of stone-lime is in each gallon of the lime-water. Mark to allow for evaporation as in the case of the copper-sulphate solution.

After the stock solutions have been prepared to make an 8-8-40 Bordeaux mixture, proceed as follows:—

Use two barrels besides the spray-barrel. In the one barrel put 2 gallons of the copper-sulphate solution, which, according to the strength of the solution as described above, will contain 8 lb. of copper-sulphate. Dilute this to 20 gallons by adding 18 gallons of water. In the other barrel place stock solution of lime containing 8 lb. of stone-lime, and dilute to 20 gallons with water. Stir both these well and then pour them into the spray-barrel, so that two liquids will unite as they enter. By following these directions carefully a Bordeaux mixture will be prepared which will stand in suspension well, stick well to the tree, and be effective. It is advisable to use this mixture within a few hours after making.

The writer has had good results from using Bordeaux mixture manufactured as follows, where a large spray outfit was in use: Place the required quantity of granulated copper-sulphate (ordinary copper-sulphate ground fine) in a cloth strainer and allow the water to run through this as the tank is being filled. This will dissolve the copper-sulphate. When the tank is nearly full, add the required quantity of concentrated milk of lime, stirring the mixture well as the lime is being added. Then fill the tank full with water, being sure to keep the mixture well stirred. This mixture possibly does not stay in suspension as well as the one manufactured as described before, but it is quicker made, requires less labour, and no difference has been noticed in results in the use of the two mixtures. However, the first-given method is considered the best and is generally recommended, the latter being given for the benefit of those who desire to experiment to the advantage of time and expense of manufacture. In the latter case never add the concentrated copper-sulphate solution to the diluted lime-mixture, as it will give a poor mixture as compared with the reverse method of mixing.

It is advisable to strain the lime, especially where it contains considerable sediment. For this purpose a brass strainer fixed in a cone shape in the bottom of a pail with an outlet is very satisfactory. By pouring the mixture on the top of the cone it will strain readily with little clogging, and is more satisfactory in this respect than a flat strainer.



Limbs of apple-tree badly attacked by canker.

The following tests will show whether the copper-sulphate has all been neutralized by the lime:—

Potassium ferrocyanide (in solution)—No change on adding to mixture. If more lime is required it turns a purple or reddish colour.

Blue litmus-paper—No change. If more lime is required it turns a red colour.

Knife-blade—If metallic copper precipitates on the blade the mixture requires more lime. The potassium ferrocyanide is the best and cheapest indicator.

Bordeaux mixture is to be recommended where the disease is serious. In other places the use of lime-sulphur will be satisfactory and more economical, as besides its fungicidal value it has considerable insecticidal value.

SPRAY OUTFITS.

As far as results in spraying for canker are concerned, the type of sprayer makes little difference providing thorough work is done. With old trees a sprayer will be required which will give higher pressure than is required on a younger tree, in order to fill all cracks in the bark. In all cases high pressure is an advantage from the standpoint of economy, as double pressure means approximately double quantity applied or double area covered. With the present scarcity of labour and the high labour values which prevail, this is a distinct advantage. Time is also an important consideration, as the writer has seen 50 per cent. difference in results in a difference of three days' time to control some of the pests of our orchards. In buying an outfit the fruit-grower should not select his type from the standpoint of his present necessities, but look to his requirements for the near future during at least part of the lifetime of his outfit. Improvement in spraying-machines is taking place so rapidly that it is impossible to say which outfit will be the best for the next few years, though it is better to select one that has a larger capacity than the present requirements demand, simple in construction, strong, easily worked, easily cleaned, and one in which high pressure can be maintained. See that the pump especially, and, as far as possible, the parts with which the mixture comes in contact, will not be damaged by the spray, causing frequent renewal and trouble in clogging of nozzles, etc. A few figures on comparative value of spray outfits are given here for the consideration of prospective buyers of outfits. These figures will vary in different districts under different conditions, but the basis for comparing values, providing they are correct, remains constant. It will be noted here that the first cost is largely a secondary consideration, and that the main expense in spraying is due to the cost of labour, which varies with the capacity of the outfit in use.

Comparative Value of Spray Outfits.

Basis—200 barrels annual output.

(1.) Barrel Hand-pump.

Initial cost, $25.00.
Number of barrels per day, 10.

Interest on investment, 7 per cent.	$ 1 75
Depreciation in value, 10 per cent.	2 50
Twenty days, two men at $2.50	100 00
Twenty days, horse at $2.00	40 00
	$144 25

(2.) Duplex Sprayers (including Bean Magic).

Initial cost, $68.00.	
Number of barrels per day, 20.	
Interest on investment, 7 per cent.	$ 4 76
Depreciation in value, 10 per cent.	6 80
Ten days, three men at $2.50	75 00
Team, ten days at $3.50	35 00
	$121 56

(3.) Gasoline-power Outfit.

Initial cost, $400.00.	
Number of barrels per day, 40.	
Interest on investment, 7 per cent.	$ 28 00
Depreciation in value, 10 per cent.	40 00
Five days, three men at $2.50	37 50
Five days, team at $3.50	17 50
Seven gallons gasoline at 30 cents	2 10
	$125 10

Basis—400 barrels annual output.

(1.) $300.25. One outfit—would require two or more.

(2.) $216.56.

(3.) $174.70. Engine for other purposes.

Cost varies according to facilities for mixing, age of trees, varieties, etc.; but basis for comparing value remains constant.

For the dormant season's spraying a nozzle of the Bordeaux type will do the most thorough work, especially on the older trees. The angled nozzle suits the writer best for all purposes.

Permit me again to draw your attention to the necessity of thorough and systematic work by spraying at the right time and with the right mixture. Much of the unsatisfactory results obtained in combating fungus pests has been due to insufficient knowledge of the pest under control. By reading this bulletin carefully, the fruit-grower should be able to obtain at least a "fighting" knowledge of the pest. It is to be hoped that fall spraying in the future will be carried on generally, regularly, and systematically, especially in the Coast districts.

J. F. CARPENTER, B.S.A.,
Assistant Provincial Horticulturist.

Department of Agriculture,
Victoria, B. C.

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